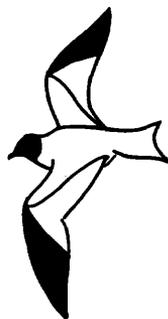


CALIFORNIA BIRDS



Volume 3, Number 2, 1972

NOTES ON BIRDS KILLED IN THE 1971 SAN FRANCISCO OIL SPILL

John Smail, David G. Ainley and Helen Strong

On 18 January 1971 two tankers collided in the mouth of San Francisco Bay and 840,000 gallons of bunker C fuel oil were spilled. Tides and currents quickly moved most of the oil out of the Bay, and in the following several days it spread 17 km out into the Pacific Ocean and along the coast from Drake's Bay on the Point Reyes National Seashore southward almost to Point Año Nuevo. The oil thus covered a sizable portion of one of the most important wintering areas for aquatic birds on the west coast of North America.

This paper summarizes bird mortality resulting from the oil and presents information gained from inspecting over 1100 bird carcasses.

METHODS

It was not possible to have birds counted by experienced observers at all of the three dozen cleaning stations that handled oiled birds. From counts made at various times we were able to establish the bird loss at nine stations. At three of the major stations - Bolinas, Pacifica (Linda Mar), and Tiburon - and on Southeast Farallon Island counts were established at the outset and maintained throughout the operation. Data from those four stations were used to compare the relative degrees that different species were affected.

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The bodies of over 1100 birds were inspected from those stored at the San Francisco Zoo. On about 600 of these, measurements of the flattened wing were made to the nearest millimeter with a rule having a flange at the zero end. Other measurements were made with dial calipers to the nearest 0.5 mm. Bill depth was measured at the anterior edge of the nares, and other measurements were done according to the methods of Storer (1952). Birds were sexed by inspection of gonads. When possible ages were determined from measurements and characteristics of plumage and bill. The color phases of Western Grebes were noted according to the following criteria (Storer, 1965). In dark phase birds the bill is greenish-yellow and the black of the crown extends to the eyes and to the gape; and in light phase birds the bill is orange-yellow and the black of the crown reaches neither the eyes nor the gape. In addition the back of light phase individuals is noticeably paler.

MORTALITY

Oiled birds were found on beaches from Tomales Bay to Santa Cruz (Figure 1). A mortality of 7000 birds was estimated by the California Department of Fish and Game and was quoted by them to the news media (R. Lassen, pers. comm.), but the basis for their calculation has not been disclosed. During our counts at eight cleaning stations and Southeast Farallon Island we tallied the arrival of 4629 oiled birds. The tally was as follows: on 20 January 211 birds were processed at Alameda Naval Air Station, 109 at the Family Dog Ballroom (San Francisco), 274 at Richmond, 320 at the Humane Society in Novato; 19 to 26 January, 1148 at Bolinas Marine Station; 19 to 27 January, 924 at Tiburon; 19 January to 1 February, 186 at Southeast Farallon Island; and 19 January to 2 February, 1432 at Pacifica (Linda Mar). Considering the stations from which we did not obtain figures (e.g., Santa Cruz, etc.) and the days we did not make counts at others, we estimate that at least 6000 birds passed through cleaning stations.

Certainly, other dead birds were disposed of without being taken to cleaning stations. Reviews of data for other spills and bird disasters indicate that at best a quarter and more probably only an eighth of the affected birds arrive on the beach dead or alive. The remainder wash out to sea or sink (Bourne, 1968; 1970). Based on this information a minimum mortality of 20,000 birds would not be unreasonable. In any case, bird loss resulting from the San Francisco

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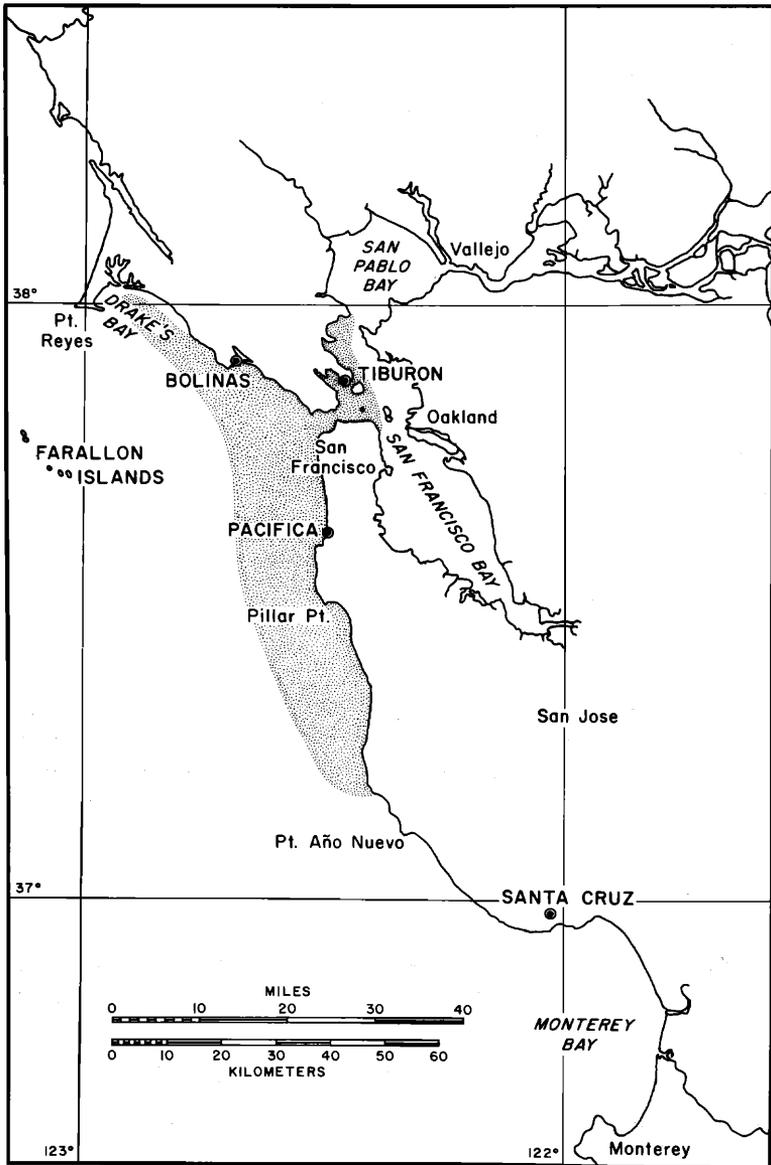


FIGURE 1. The distribution of oil slicks (shown in hatchings) in central California coastal waters resulting from the 18 January 1971 oil spill.

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oil spill was much greater than that at Santa Barbara in 1969, which was put at 3686 (1969, unpubl. report by California Department of Fish and Game). Mortality from the San Francisco spill was therefore similar to that in the well publicized *Torrey Canyon* spill of 1967 in the English Channel. In that spill 8000 birds were found for cleaning and a mortality of 40,000 to 100,000 birds was estimated (Bourne, 1968, 1970).

In the San Francisco spill the heaviest losses (Table 1) were suffered by Western Grebes (*Aechmophorus occidentalis*), Surf and White-winged Scoters (*Melanitta perspicillata* and *M. deglandi*), and Common Murres (*Uria aalge*). The pattern of loss is consistent with Bourne's (1968) observation that for the species present at the time of the disaster, those best adapted to an aquatic existence and most poorly adapted to land, and even flight, are affected most by oil pollution. These species almost never come to land during the winter. Another pattern evident in the San Francisco spill was that species that spend the night on the water were worst hit. Many more grebes and murres were oiled than were cormorants (*Phalacrocorax* spp.) and gulls (*Larus* spp.) even though the latter two groups were using the affected ocean areas just as heavily in January (PRBO unpubl. data). Cormorants, although as awkward on land as murres and grebes, roost at night on rocks, cliff ledges, and buoys because their plumage becomes waterlogged after a couple of hours in the water (Rijke, 1968). During daylight cormorants and gulls, which also roost at night on land, were apparently able to detect and avoid oil (Bourne, 1968; Straughan, 1971), but species resting on the water during the night were taken unawares.

MEASUREMENTS

Table 2 summarizes data taken for three species available in sufficient numbers for analysis. Measurements of murres in breeding plumage fell within the range given by Storer (1952) for the race *U. a. californica*. They must have originated from the Farallon Islands and the two breeding colonies near Point Reyes. Murres in winter plumage were in the size range for immatures of the race *U. a. inornata* originating from British Columbia and Washington, although a few of the smaller individuals in this group may have been *californica* immatures (Storer, 1952; pers. comm.). Since none of the birds in winter plumage had the ridges and thickenings of the upper mandible that are characteristic of the adult bill (Storer, 1952;

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Table 1. Birds received at the four cleaning/receiving stations that were censused throughout the operation.

SPECIES	STATION				TOTAL	GROUP % OF TOT.
	Bolinas	Farallon Is.	Tiburon	Pacifica		
Common Loon	10		9	9	28	-3
Arctic Loon	8		13		21	
Red-throated Loon	38		9	17	64	
Loon spp.			1		1	-57
Western Grebe	797	1	555	702	2055	
Red-necked Grebe	2					
Horned Grebe	-24		11	9	-57	
Eared Grebe			13			
Pied-billed Grebe	1				1	
Double-crested and Brandt's Cormorant	6		12	3	21	-1
Pelagic Cormorant	2				2	-1
Pintail			1		1	
Canvasback	2		6		8	
Ring-necked Duck			3		3	
Scaup spp.	3		4		7	
Goldeneye spp.	2		4		6	
Bufflehead	1		6		7	
Duck spp.	12		3		15	
Common Scoter			10		10	
White-winged Scoter	69	1	77	-380	716	
Surf Scoter	69		120			
Scoter spp.	7		4		11	-1
Ruddy Duck	14		24	3	41	
Red-breasted Merganser	4		2		6	
American Coot			20	1	21	
Willet	1				1	
Sanderling			1		1	
Glaucous-winged Gull			2	1	3	
Herring Gull	1				1	
Western Gull	2		2		4	
California Gull	2				2	
Ring-billed Gull	1				1	
Mew Gull	2		1		3	
Gull spp.	2		1	3	6	
Common Murre	68	184	10	302	564	-15
Rhinoceros Auklet				2	2	
	<u>1148</u>	<u>186</u>	<u>924</u>	<u>1432</u>	<u>3690</u>	

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Table 2. Analysis of measurements (in mm.) taken on three species. Bill length is length of the exposed culmen; bill depth is at the anterior edge of the nares; and wing is length of the flattened wing. The last two columns give, respectively, the probabilities that differences in means are due to chance between males (♂) and females (♀), and for murre, between birds in breeding (B) and winter plumage (W). V is the coefficient of variation.

MEASUREMENT	SEX	N	RANGE	MEAN	SE	SD	V	P(♂-♀)	P(B-W)
COMMON MURRE ADULTS IN BREEDING PLUMAGE									
Bill length	♂ ♀	48	45.0-54.0	49.3	0.30	2.08	4.21	$\underline{P} < 0.001$	$\underline{P} > 0.6$
Bill depth	♂ ♀	46	42.0-50.0	47.2	0.28	1.92	4.06	$\underline{P} < 0.01$	$\underline{P} > 0.5$
Tarsus	♂ ♀	46	13.0-15.5	14.9	0.09	0.63	4.26	$\underline{P} < 0.001$	$\underline{P} < 0.001$
Wing	♂ ♀	28	38.0-42.0	39.9	0.19	1.05	2.63	$\underline{P} > 0.2$	$\underline{P} > 0.4$
		26	38.0-41.0	39.6	0.19	0.97	2.45	$\underline{P} > 0.3$	$\underline{P} > 0.01$
		34	202-220	208	0.99	5.78	2.78	$\underline{P} > 0.4$	$\underline{P} < 0.001$
		37	200-221	209	0.76	4.71	2.25		$\underline{P} < 0.001$
COMMON MURRE IMMATURES IN WINTER PLUMAGE									
Bill length	♂ ♀	100	44.0-53.0	48.7	0.20	2.03	4.16	$\underline{P} < 0.001$	
Bill depth	♂ ♀	98	43.0-52.0	47.4	0.18	1.81	3.81	$\underline{P} < 0.01$	
Tarsus	♂ ♀	98	12.0-15.0	13.2	0.08	0.76	5.76	$\underline{P} > 0.1$	
Wing	♂ ♀	63	37.0-43.0	40.1	0.16	1.24	3.09	$\underline{P} > 0.2$	
		67	37.0-41.0	39.4	0.12	0.95	2.41		
		82	195-220	205	0.60	5.44	2.65		
		82	194-219	204	0.57	5.19	2.54		
RED-THROATED LOON									
Bill length	♂ ♀	12	52.0-57.0	54.6	0.66	2.27	4.15	$\underline{P} < 0.001$	
Bill depth	♂ ♀	23	48.0-55.0	51.4	0.53	2.53	4.92	$\underline{P} < 0.001$	
Wing	♂ ♀	12	11.0-13.5	12.2	0.21	0.73	5.98	$\underline{P} < 0.001$	
		23	9.5-12.0	10.6	0.12	0.58	5.47	$\underline{P} < 0.001$	
		12	278-294	286	1.71	5.92	2.07		
		23	264-285	275	1.56	7.45	2.71		
WESTERN GREBE									
Bill length	♂ ♀	56	67.0-80.0	73.4	0.46	3.48	4.74	$\underline{P} < 0.001$	
Bill depth	♂ ♀	48	58.0-71.0	64.2	0.43	3.00	4.67	$\underline{P} < 0.001$	
Wing	♂ ♀	56	9.5-13.0	11.7	1.04	0.78	6.66	$\underline{P} < 0.001$	
		48	8.0-11.0	9.3	1.00	0.69	7.41	$\underline{P} < 0.001$	
		56	192-214	202	0.90	6.75	3.34		
		48	184-203	191	0.98	6.80	3.56		

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Ainley, pers. obs.) we concluded that there were no *inornata* adults in our sample. This indicates that *U. a. inornata* adults winter farther north closer to their breeding colonies. Individuals in breeding plumage had larger gonads than those in winter plumage.

There is a ratio of 198 *inornata* birds to 94 *californica* in our sample but this is not a true measure of the subspecific composition of the Common Murres off the central California coast in winter. During the time of the spill most but not all the murres that breed on the Farallon Islands spent the nights on the breeding ledges. This they typically do on many nights in January. The *inornata* individuals, all of which spend the night on the water on their wintering grounds, were more susceptible to oiling.

There are no studies of geographic anatomical variation in the Red-throated Loon (*Gavia stellata*) nor in the Western Grebe (Palmer, 1962). Thus we were not able to determine the area of origin for these common California birds. We present our measurements in the event of future studies on geographic variation and to characterize the populations of these species wintering in central California waters. Storer (1965) suggested that the ratio of light to dark phase Western Grebes could vary geographically and, thus, ratios might be used to determine the breeding range of winter populations. But with data only now being accumulated on color phase ratios in breeding populations, it is not yet possible to use this method. Of 487 grebes we inspected, only 50, or 10 percent, were of the light phase. Interestingly, of the Western Grebes collected during the winter in central California coastal waters that were inspected by Dr. Storer in museum collections, 50 percent were light phase. Comparison of this ratio with that which we obtained suggests that museum collectors have selected light phase birds to a degree disproportionate to their occurrence in nature probably because light phase birds appear brighter and cleaner than dark ones. Dr. Storer pointed out this difficulty in working with museum grebe collections. Determinations of color phase ratios in populations at their breeding areas are needed.

We determined sex ratios for five affected species: Red-throated Loon, 11 ♂♂, 23 ♀♀; Western Grebe, 420 ♂♂, 299 ♀♀; White-winged Scoter, 25 ♂♂, 27 ♀♀; Surf Scoter, 35 ♂♂, 22 ♀♀; Common Murre (*californica*), 57 ♂♂, 50 ♀♀; and Common Murre (*inornata*), 115 ♂♂, 102 ♀♀. In no species did the ratio differ significantly from a 1:1 ratio ($P > 0.05$; X^2 test). Although some of the samples were small it appears that the sexes in these species did not suffer differential

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mortality. The data also suggest that both sexes of these species winter in equal proportions in central California waters.

In presenting estimates of birds killed and observations on dead birds we should point out that it will be impossible to determine how populations as a whole are affected in incidents of this kind on the west coast until much more research is done on the status and population sizes of our west coast aquatic birds. The San Francisco oil spill clearly underlined the lack of and need for this kind of information.

ACKNOWLEDGEMENTS

We wish to thank others on the staff and volunteers of Point Reyes Bird Observatory for their assistance in collecting data, especially J. Winter, T. J. Lewis, R. M. Stewart, B. Clow, and R. Scheible. We appreciate that the San Francisco Zoological Society and especially P. Maxwell allowed storage of bird specimens for so long in their freezer. Diann MacRae supplied data from the Pacifica cleaning station; and Mrs. Hubert Fry coordinated the count at Tiburon. N. Story kindly prepared the figure. This is contribution 41 of the Point Reyes Bird Observatory.

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